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BREEDING HABITS OF THE BARRED DOVE IN HAWAII WITH NOTES ON WEIGHTS AND SEX RATIOS

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The Barred Dove (*Geopelia striata*), a native of Malaya, has not only become successfully established in the Hawaiian Islands following its introduction in 1922 but has increased to the point where it is one of the most common birds in Hawaii today. It now occupies all suitable habitat on the major islands except for the island of Hawaii where its first occurrence dates to approximately 1935 and its ranges and populations are still increasing. Densities up to 800 Barred Doves per square mile are common; and in some places, particularly around water holes and in fields where a source of preferred food is abundant, concentrations may exceed a thousand birds. As a contribution toward an understanding of the phenomenal increase and spread of this species, the following observations on the breeding habits of the Barred Dove are presented. They were made during a survey of the game birds in the Hawaiian Islands conducted from February, 1946, through July, 1947, as the initial step in the Federal Aid-Wildlife Program (1-R) of the Board of Commissioners of Agriculture and Forestry of the Territory of Hawaii (Schwartz and Schwartz, A Reconnaissance of the Game Birds in Hawaii, 1949).

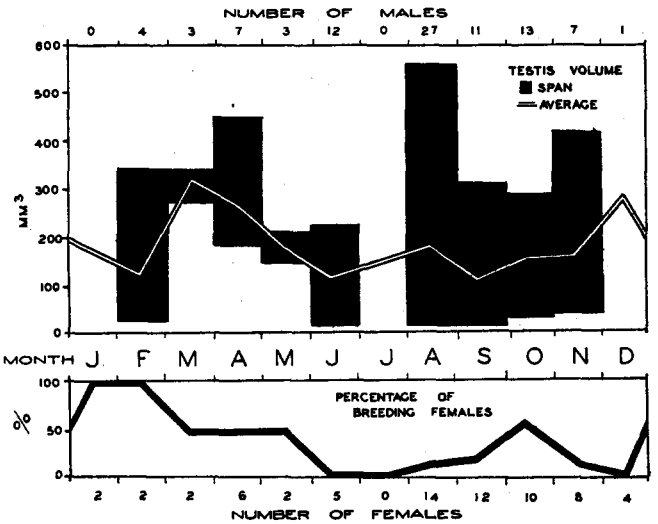
BREEDING HABITS

Figure 37 presents the span and average volume of testes (roughly computed in cubic millimeters by measuring length $\times$ width $\times$ depth of both testes per individual) of 88 adult-plumaged male Barred Doves collected throughout the year. The percentage of breeding (determined by the presence of maturing Graafian follicles) in 67 adult-plumaged female Barred Doves collected during the same period is given in figure 38. These indications of breeding correspond very closely with observations on the courting displays and accompanying songs of male Barred Doves; the latter activities were observed at any time throughout the day but they were particularly common during the early morning hours. Singing became very intense during late January and reached a peak extending from February through April. From May through July songs were less evident but thereafter became more obvious and continued so through October. There was a decided decline in the amount of singing from November through early January. In every month we observed other indications of breeding, such as nests with eggs, nest-free juveniles, or (collected) adults with crops which indicated they were feeding squabs. Evidence from these sources suggests that Barred Doves in Hawaii breed throughout the year, but two periods of increased activity are evident.

This extensive breeding season is partly attributable to the equable climate in the range of this species in Hawaii which extends from sea level to 4,000 feet elevation. Here, mean annual temperatures grade from 75°F. at sea level to 60°F. at the highest occupied elevation, with a fluctuation of less than 8°F. in the monthly means throughout the year; and rainfall varies from less than 10 to 160 inches annually. However, the highest densities occur in the warmer and drier portions of this range where the foods preferred by this species are most abundant and where rainfall conditions are

seemingly more optimum for breeding. Probably mean annual temperatures lower than 60°F. and annual rainfall higher than 160 inches both limit the distribution of the Barred Dove in Hawaii (Schwartz and Schwartz, Wilson Bulletin, in press).

Barred Doves nest above the ground in shrubs or trees, including species planted for orchards or ornamental purposes as well as those occurring naturally. Six nests under our observation were located as follows: seven feet above the ground in the outer



Figs. 37 and 38. Breeding activity of the Barred Dove in Hawaii. Above (fig. 37), testis volume. Below (fig. 38), percentage of breeding females.

branches of a lime tree (*Tilia* sp.); four and eight feet above the ground, respectively, in the shrub koa haole (*Leucaena glauca*); seven feet above the ground in the outer branches of an alligator pear tree (*Persea americana*); eight feet above the ground in the outer branches of a mango tree (*Mangifera indica*); and eleven feet above the ground in the outer branches of a sandbox tree (*Hura crepitans*).

The nests were saucer-shaped, measuring between three and one-half and four and one-half inches in diameter. A basal platform was constructed of small twigs, rootlets, and tendrils or grasses between approximately one-eighth and one-sixteenth inch in diameter; and a meager lining was usually composed of finer material of the same nature (fig. 39). One interesting selection of materials occurred in a nest located at the animal quarantine station in Honolulu, Oahu. The nest platform was made of entire plants of Bermuda grass (*Cynodon Dactylon*) and lined with fine bits of steel fibers taken from a woven mesh screen used to shade the dog kennels from the sun. These steel fibers presented an appearance similar to tendrils used in other Barred Dove nests. Most nests are flimsily constructed and during strong winds are frequently reported to be destroyed or, as in the case of one nest under our observation, to have the eggs shaken out of them.

Measurements of eggs taken from four nests are as follows:

	Egg 1	Egg 2
Nest 1	17 × 20 mm.	
Nest 2	19 × 21	19 × 21 mm.
Nest 3	18 × 25	18 × 24
Nest 4	20 × 25	20 × 22

The weights and general external development of two nestling Barred Dove squabs from near hatching until ten days afterwards are presented here. On June 11, 1947, a Barred Dove nest was found approximately eleven feet above the ground in the outer branches of a sandbox tree. This is the nest described above with a sparse lining of steel fibers. It contained two eggs (measurements given under Nest 4 above) being incubated by an adult. The following day an incubating adult was observed on the nest.

Fig. 39. Adult Barred Dove incubating eggs. Wailua, Kauai, elevation 150 feet, February 26, 1947.

On June 13 at 7 p.m., an adult was flushed from the nest and an examination showed that one egg had hatched. Since the squab was quite damp, hatching was estimated to have occurred during that afternoon. There was no evidence of the egg shell in the nest or on the ground. A sparse covering of light yellow down marked the main feather tracts of the newly-hatched squab; the ventral surface down was slightly lighter than the dorsal. The skin of the head and body was dark brownish-purple; the bill was light pink with a dark purple ring near the tip which was white and possessed a small egg tooth. The feet were the same color as the bill but slightly darker. The eyes had not opened. The squab weighed 5.0 grams. The shell of the other egg was pipped.

On June 15 at 4 p.m., an examination of the nest showed that the second egg had hatched. From the development of this squab, we estimated that hatching had occurred on June 14. This younger squab weighed 8.4 grams; its eyes were still closed. The older

squab weighed 11.4 grams; its eyes were open but the bird frequently closed them. The sheaths of the primaries were slightly visible.

On June 17 at 5 p.m., the sheaths of the primaries and secondaries of the older bird were quite prominent; those of parts of the crown, dorsal body area, femoral tracts, scapulars, rectrices, and lesser wing coverts were clearly visible but less evident. The egg tooth was still present. The feet had changed to a slate-blue color. This bird weighed 16.0 grams. It exhibited an attempt at defense by raising the wing nearest the observer's intruding hand. On the younger squab, the sheaths of the scapulars, rectrices, and

Fig. 40. Squab of the Barred Dove six days after hatching. Note accumulation of droppings at edge of nest. Honolulu, Oahu, sea level, June 19, 1947.

femoral tracts were just appearing while those of the primaries and secondaries were more evident. This squab weighed 13.0 grams.

On June 19 at 4 p.m., the plumage of the primaries, secondaries, rectrices, and femoral tracts of the older squab was beginning to project from the sheaths (fig. 40). The bird weighed 25.0 grams. On the younger squab, sheaths marking most feather tracts were quite prominent. This bird weighed 22.0 grams.

On June 21 at 4 p.m., the feather development of the older bird was as follows: the plumage of the rectrices, dorsal body area, breast, and outer wing except the primary coverts was projecting about one-third from the sheaths. The juvenal plumage was just beginning to protrude from the sheaths on the crown; but on the remaining portion of the head, sheaths were only becoming prominent. The egg tooth was gone. This older squab was capable of perching easily on the observer's finger; its weight was 29.5 grams. The younger squab showed a similar plumage development except that the

plumage on the wings and body projected only about one-fourth from the sheaths and no feathers extended from the sheaths on the crown. The egg tooth was still present; the bird could only perch feebly on the observer's finger. This younger squab weighed 28.0 grams. The nestlings were beginning to fill the nest to capacity.

On June 23 at 5 p.m., both squabs were well feathered except for the facial region but they could still be told apart easily. The older bird now weighed 30.2 grams, the younger 30.4 grams. The upper surface of the wings showed the greatest development, the primaries and secondaries having lost most of their natal down plumes. The under

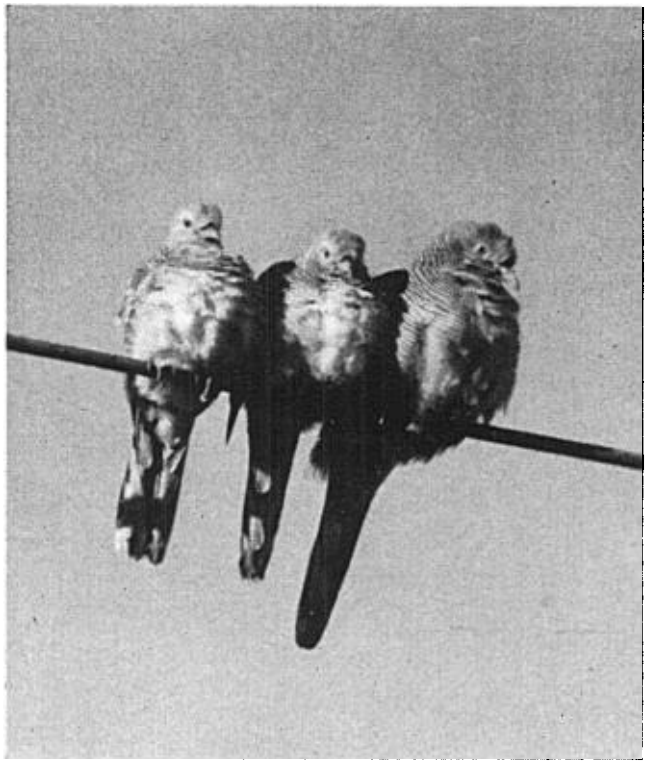


Fig. 41. Adult Barred Dove with two fledglings. Lihue, Kauai, elevation 200 feet, January 17, 1947.

surface of the wings were not yet feathered. By this time the bills had become brown but still retained a light tip. The egg tooth was gone on the younger squab. Both birds perched well and moved about the nest considerably.

On June 25 at 5 p.m., an observation of the nest disclosed that predation had occurred. Only the two wings, feet, gizzard, and some dried connective tissue remained of one bird. There was no trace of the other. From an examination of the wing bones which were broken and gnawed, we believe this predation to have been the work of a tree-climbing rat, either *Rattus rattus rattus* or *R. r. alexandrinus*. A comparison of the development of these two young at nine and ten days, respectively, after hatching with that of two other squabs at the time of their nest leaving leads us to believe that Barred Dove squabs leave the nest approximately fourteen days after hatching. Adults and their recently nest-free young, which are easily distinguished by size (fig. 41), are quite

commonly observed. One family of two adults and their two recently nest-free young under our observation stayed together for at least one week.

The fully-developed juvenal plumage is generally similar to the adult in pattern and coloration except that in the juvenile the contour feathers are lighter tipped, the primaries and primary coverts are distinctly redder, and the barring continues dorsally onto the top of the head and farther ventrally on the breast.

Twenty-five Barred Doves in juvenal plumage were examined for the bursa of Fabricius and all possessed a bursa measuring from 4 to 11 millimeters in length except one bird which had no bursa. Forty-one birds in adult plumage had no bursa while 14 others showed this structure measuring from 3 to 12 millimeters in length. Five doves in juvenal plumage were in breeding condition (determined by testis size compared to that of adults taken during the same month and by development of Graafian follicles in females). No examination for the bursa was made in three of these five (two females and one male) but one male had a bursa 4 millimeters in length while another male had no visible bursa. Riddle (Am. Jour. Physiol., 86, 1928:248-265) found in other kinds of doves (genus *Streptopelia*) that the bursa of Fabricius usually, but not invariably, involuted at sexual maturity. In our examination for bursae in both adult-plumaged and juvenal-plumaged birds, we found no correlation between bursal length or absence and the condition of molt of the wing primaries.

WEIGHTS AND SEX RATIOS

The weights of forty-six Barred Doves are as follows:

	Average	Minimum	Maximum
20 adult-plumaged males	59.7 grams	54 grams	65 grams
10 adult-plumaged females	55.2	51	61
5 nest-free juvenal-plumaged males	53.8	50	61
11 nest-free juvenal-plumaged females	51.2	42	59

Sex ratios obtained from 207 Barred Doves in Hawaii are as follows:

	Number of males	Number of females	Males per 100 females
207 adult-plumaged and nest-free juvenal plumaged doves	111	96	115 : 100
156 adult-plumaged doves	89	67	132 : 100
51 nest-free juvenal-plumaged doves	22	29	75 : 100

SUMMARY

Barred Doves breed throughout the year in Hawaii but two periods of increased activity occur.

The development of two squabs from hatching until ten days afterwards is described.

Juvenal-plumaged birds show lighter-tipped contour feathers and redder primaries and primary coverts than adult-plumaged birds. Both juvenal-plumaged and adult-plumaged birds were found to possess a bursa of Fabricius. Lack of the bursa also occurred in both groups.

The average weight of 20 adult-plumaged males was 59.7 grams and of 10 adult-plumaged females was 55.2 grams.

The sex ratio in 207 adult-plumaged and nest-free juvenal-plumaged birds was 115 males : 100 females.

Conservation Commission, Jefferson City, Missouri, May 30, 1950.